THE EARTH IN THE LENS OF "SALYUT-3"

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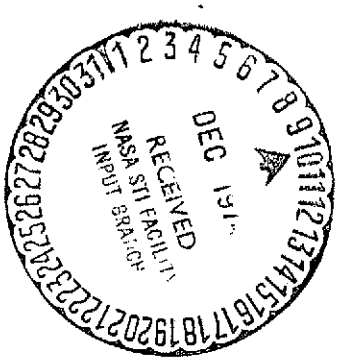
(NASA-TT-F-16028) THE EARTH IN THE LENS OF SALYUT-3 (Scientific Translation Service) 13 p HC $3.25 CSCL 22C

N75-10964

Unclas
G3/12 02861

Translation of: "Zemlya v ob"yetive 'Salyuta-3'", Aviatsiya i kosmonavtika, No. 9, Sept. 1974, pp. 38-40.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C. 20546 NOVEMBER 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F 16,028	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle THE EARTH IN THE LENS OF SALYUT-3		5. Report Date November 23, 1974 6. Performing Organization Code
7. Author(s) V. Ivanov		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108		11. Contract or Grant No. NASw-2483 13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes
Translation of: "Zemlya v ob'yektive 'Salyuta-3'", Aviatsiya i kosmonavtika, No. 9, Sept. 1974, pp. 38 - 40.

16. Abstract

A description is given of experiments performed by the cosmonauts on "Salyut-3" and "Soyuz-14". The geological-morphological objects on the Earth, as well as atmospheric formations and phenomena, were studied. It is concluded that this work represents one of the first steps in the conquest of space.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	11	

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THE EARTH IN THE LENS OF SALYUT-3

V. Ivanov*

One important page has been written by the Soviet people in the chronicle of the conquest of space. An extensive program of scientific-technical and medical-biological studies and experiments has been successfully completed by the crew of the orbital station "Salyut-3," P. R. Popovich and Yu. P. Artyukhin. /38**

On 19 July, after 15 days onboard the station, the cosmonauts changed to the transport spacecraft "Soyuz-14," and at 15 hours 21 minutes landed 140 kilometers southeast of the town of Dzhezkazan.

For their successful completion of the flight on the orbital scientific station "Salyut-3" and the transport spacecraft "Soyuz-14," and for their great courage and heroism, by the orders of the Presidium of the Higher Soviet of the USSR, Cosmonaut Pavel Romanovich Popovich, Hero of the Soviet Union, was awarded the Order of Lenin and a second medal "Gold Star." Yuriy Petrovich Artyukhin was named Hero of the Soviet Union and titled "Flier-Cosmonaut of the USSR."

Some of the experiments performed by these cosmonauts during this flight are described herein.

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**Numbers in the margin indicate the pagination of the original foreign text.

The flight of the manned scientific orbital station "Salyut-3" is a new stage of space research carried out in our country under the program of the study and conquest of circum-terrestrial space for peaceful purposes. One of the basic problems confronting the crew of the station, P. R. Popovich and Yu. P. Artyukhin, was to study the geological-morphological objects on the Earth, as well as atmospheric formations and phenomena.

Of what importance were these studies and how did the cosmonauts carry them out?

In the reports during the flight, it was indicated that the cosmonauts observed and photographed different objects on the Earth. In particular, photographs were taken of the Caucasus and the Ustyurt Plateau. It was found that they can be used in studying the geological structure of these regions, in controlling agglomeration practices, in establishing forest resources, and in studying the dynamics of the coastline of the sea.

On one of the days the cosmonauts made photographs above extensive ravine and mountainous regions of the republics of Central Asia and Pamir. These photographs were necessary to reveal areas holding great promise in terms of mineral resources, a determination of land which has been salinized, and also for determining promising land resources, and evaluating the present state and predicting the movement of glaciers.

The crew used an optical viewfinder to observe the state and development of cloud formations and to photograph them. The cosmonauts made spectrographic measurements of individual natural formations on the surface of the Earth. These data were to be used in a catalog of the characteristic types of the Earth's surface, in order to improve the methods of studying natural resources and to evaluate the state of the atmosphere.

We have named only a small portion of the experiments performed in the flight, as well as the basic methods of obtaining information regarding the Earth and its atmosphere — visual observations, photographs, and spectrographic measurements.

Why was so much attention paid to studying the geological-morphological objects on the surface of the Earth and the atmospheric formations during the flight?

Meteorological, geodesic, navigational, and other satellites of an applied nature already exist. All of them symbolize the development of an important stage in cosmic research and have contributed many useful results. However, these satellites represent only the first step in studying our planet by using space technology. There are unlimited possibilities for studying the nature of the Earth, the riches in its depths and oceans from space.

Prolonged cycles of continuous and complex observations, which encompass an extensive class of problems in the studies, may be most effectively realized by means of long duration orbital stations, whose crews will include specialists trained to carry out the scientific programs.

One of the important advantages of these stations is that the conditions which develop can be analyzed onboard, the objects to be studied can be selected under the most advantageous conditions for observing them, and also the space equipment can be evaluated.

This is how cosmonauts P. R. Popovich and Yu. P. Artyukhin participated in the flight.

However, this does not exhaust the advantages of orbital stations. The presence of a crew onboard the spacecraft makes possible effective and prolonged operation of the scientific equipment, and when necessary any malfunctions in their operation may be eliminated. As the crew on the orbital stations is relieved, it is possible to add materials from experiments performed on the Earth (cassettes with movie and photographic film, different research objects) for a preliminary analysis, and for correcting subsequent studies if desired.

The day before being launched from orbit, the cosmonauts informed the television viewers about the program to be completed and the preparation of research materials to be returned to the Earth. A certain portion of the scientific information obtained was already "reported" during the flight to the Earth, using communication channels, and a "material" part of this information in the form of photographic and movie film samples for subsequent analysis on the Earth, objects of experiments, journals kept on board, and other information was carefully recorded and transported onboard "Soyuz-14."

The flight of the Soviet scientific orbital station "Salyut-3" represented proof of the fact that cosmonautics has reached maturity. Its importance to the national economy increases with each passing year.

Atmospheric space optics as a means of studying the Earth from space has been developing very rapidly in the last few years. Optical equipment placed onboard the stations has made it possible to study the atmosphere and different properties taking place within it. Beginning with the first space flights, atmospheric optics has been given a great deal of attention. Along with photographs and spectrographic measurements, visual observations of the cosmonauts are of great importance. In these observations, they can establish even insignificant details in the global picture of the atmosphere and the space near the Earth.

The importance of visual observations from manned spacecraft is first of all due to the fact that the most perfect optical device, the human eye, can be used to perform numerous experiments on determining the brightness and color of different surfaces and of the atmosphere, to observe atmospheric phenomena, /39 to determine the brightness of the stars, the Moon, and the planets, and to follow cyclones, storms, and clouds. The characteristic features as observed from space of the relief and of the coastlines, the specific color of the continents, oceans, and seas under different conditions of solar illumination and under differing meteorological conditions make it possible to perform a visual orientation of the spacecraft or station on the diurnal side of the Earth, along with the use of the basic navigational instruments.

Among the different ways to perform remote control recording of the Earth's surface from space, photography has occupied, and will continue to occupy, a predominant position. There are numerous reasons for this. First of all, no other type of recording contains in one frame of the photograph such a great amount of information. No receiver (except for a laser) can

give resolution of such fine details of the Earth. In addition, photography has universal applications — from physics of the atmosphere to structural geology, including all of the other branches of terrestrial science. Finally, photography is suitable for visual analysis more than other types of information. In space photography, technical equipment has now been developed, such as methods of interpreting photographic images of the Earth from space, for solving scientific and practical problems.

The requirements for space photography have already been established. The lowest altitude from which photography is possible is the altitude of possible orbital motion of the spacecraft or station. This equals approximately 100 km. The upper limit is bounded by the small scales of the image of the terrestrial sphere. Photographs of the Earth, made from automatic interplanetary stations at a distance of 60 — 90,000 km, contain very valuable scientific information. However, an altitude range of 200 — 600 km is most effective for space photography of the Earth.

The program of space photography of the Earth's surface, developed for the "Soyuz" spacecraft, has made it possible to obtain systematically different photographs of territories in our country. Much greater possibilities for scientific photography of the Earth have been opened up with the launch into orbit of stations such as the "Salyut" type. Due to their long lifetime, the cosmonauts-researchers can not only perform a great amount of photography, but can also perform experiments which require a great deal of time, repeated photography of processes taking place on the Earth's surface, and photography of one and the same objects on different films by different cameras. For the photography, they can select the optimum

atmospheric-optical conditions, and can wait for the clear weather over designated sections of the land.

What are the optimal atmospheric-optical conditions? To photograph, for example, mountainous regions, the minimum permissible altitude of the Sun must exceed 20°, since otherwise large shadows on the photographs would make it difficult to interpret them. The season in which the photography takes place is also very important, since the state of the vegetation, the presence of snow, and other natural factors have a great influence on the interpretation.

Photographing previously selected regions for purposes of geology and geography is best done in clear weather or with minimum clouds. Therefore, probablistic models for the cloudiness distribution depending on the time of year over different regions of the Earth have been developed. This is done on the basis of analyzing data over a period of several years, including photographs obtained from meteorological satellites.

The crew on "Salyut-3" also photographed the Earth. The photographs obtained made it possible for specialists to obtain many new scientific data regarding nature and resources on the regions studied. The cosmonauts greatly supplemented the "library" of spectra — the catalog of spectra of different objects on the surface of the Earth. For this purpose, on board the station there was special equipment which recorded on film, in different sections of the electromagnetic spectrum, the reflection from different objects on the land, and also types of the underlying surface.

Each object, each surface has an individual spectrum. Let us examine, for example, the forests. One is conifer, and the other is larch. It changes, depending on the time of year, soil, humidity, and other factors. Knowing these characteristics, in the future, cosmonauts can control from spacecraft in short periods of time the condition of the forests, crops, and when necessary, rapidly come to their aid in the case of diseases or invasions of pests.

On the basis of a geographical analysis of space photographs and other images (television, thermal, and others), in recent years there has been a rapid development in the scientific discipline of space methods of studying the natural medium, which is sometimes called space geography. This problem includes the study of local, regional, zonal, and planetary uniformities in the composition, structure, dynamics, and rhythms of the geographical medium by recording the electromagnetic field of the Earth from spacecraft. There is very great interest in every country in the scientific development of space geography methods. This is explained by the great scientific and economic effectiveness of space photography.

We have spoken about the scientific value of information regarding the Earth obtained from space. With respect to the economic effectiveness of putting into practice the study of natural resources by new methods, it is directly expressed by a reduction in the cost of scientific research, and indirectly expressed by an increase in the quality, reliability and detailed nature of the results.

It is still difficult to give a complete evaluation of the economic effectiveness of space photography because the use of space photography was just recently initiated and not all branches of the national economy where it could be used to advantage have been clearly determined. However, it must be kept in mind that orbital stations operating for a long period of time can provide many thousands of space photographs, and one and the same photograph can be used by tens of specialists of different branches of science on the Earth.

If we compare the cost of space photography and aerial photography, then — based on American data — in the former case the expenses are from 0.18 to 2.9 dollars per square km and in the latter case — they are 3 — 4 times greater.

Based on preliminary calculations made by American specialists, a satellite for studying the natural resources of the Earth can provide an economic savings of 50 — 60 million dollars in agriculture by 1975, in transportation and urban economy — 10 — 50 million dollars, in water resources and hydrology of the land — 35 — 100 million dollars, in marine resources and oceanology — 500 — 900 million dollars, and in geology — 100 — 600 million dollars.

The materials compiled regarding the Earth by cosmonauts P. R. Popovich and Yu. P. Artyukhin are at the disposal of scientists. One step has already been made by man in the conquest of the stellar ocean.

Translated for National Aeronautics and Space Administration under Contract No. NASw-2483 by SCITRAN, P. O. Box 5456, Santa Barbara, California 93108.